What is claimed is:

1. A method performed by a computer for filtering interference and noise of an asynchronous wireless signal comprising the steps of:

receiving an asynchronous data vector including a spreading code;

using the received asynchronous data vector, updating weight coefficients of an adaptive filter without prior knowledge of synchronization of synchronization of the spreading code;

using the updated weight coefficients information to determine synchronization of the spreading code; and

demodulating the output of the filter using the determined synchronization of the spreading code for obtaining a filtered data vector.

2. The method of claim 1, further comprising the step of dividing the data vector represented by $\mathbf{x}[i]$ into two channels $\mathbf{x}_1[i]$ and $d_1[i]$ using a transformation $\mathbf{T}_1$ on $\mathbf{x}[i]$, represented by $\mathbf{T}_1\mathbf{x}[i]$, wherein the transformed data vector $\mathbf{x}[i]$ does not contain information about a designated sender's spreading code s_1, and $d_1[i]$ contains primarily only information about the spreading code s_1 and residual data from correlation of s_1 and $\mathbf{x}[i]$.

3. The method of claim 2, wherein the transformation $\mathbf{T}_1$ is defined by

$$\mathbf{T}_1 = \begin{bmatrix} \mathbf{u}_1^t \\ \mathbf{B}_1 \end{bmatrix}, \qquad (16)$$

where $\mathbf{B}_1$ is a blocking matrix whose rows are composed of any orthonormal basis set of the nullspace of the normalized signal vector $\mathbf{u}_1 = \mathbf{s}_1 / \sqrt{\mathbf{s}_1^t \mathbf{s}_1}$.,

and where $\mathbf{B}_1\mathbf{u}_1 = \mathbf{B}_1\mathbf{s}_1 = 0.$ (17)

4. The method of claim 1, wherein the step of determining synchronization comprises the steps of:

computing $\hat{i}$, the time occurrence of the information data bit, from the equation;

$$\left| \mathrm{Re}\{y[\hat{i}]\} \right| = \max_{k \in \{0,1,...,NS-1\}} \left| \mathrm{Re}\{y[i-k]\} \right| \qquad (30c),$$

41

where $y[i] = \mathbf{w}[i]^t \mathbf{x}[i]$ is filtered output from a likelihood ratio test at clock time i detecting sequentially maximum of all likelihood tests in the set $Y[i]$ given by

$$Y[i] = \{\,|\,\mathrm{Re}\{y[i]\}\,|,\ldots,|\,\mathrm{Re}\{y[i-NS+1]\}\,|\,\},$$

where N is number of chips in the spreading code and S is number of samples per chip time.

5. The method of claim 1, wherein the step of updating weight coefficients comprises the steps of:

computing maximum likelihood estimator for $\mathbf{R}_x[i]$

$$\hat{\mathbf{R}}_x[i] = \frac{1}{L}\sum_{m=1}^{L}\mathbf{x}^{(m)}[i]\mathbf{x}^{(m)*}[i] = \frac{1}{L}\mathbf{X}_0[i]\mathbf{X}_0^t[i].$$

wherein, $\mathbf{x}^{(m)}[i]$ is an observation vector at a sampling time iT_s of the mth symbol, L is approximate independent samples of the observation vector $\mathbf{x}^{(m)}[i]$ for the initial acquisition of detector parameters, and the data is given in matrix form by

$$\mathbf{X}_0[i] \triangleq [\mathbf{x}^{(1)}[i], \ldots, \mathbf{x}^{(L)}[i]]\,;$$

computing

$$\hat{\mathbf{R}}_{x_1}[i] = \mathbf{B}_1\hat{\mathbf{R}}_{x_1}[i]\mathbf{B}_1^t = \frac{1}{L}\mathbf{B}_1\mathbf{X}_0[i]\mathbf{X}_0^t[i]\mathbf{B}_1^t$$

$$\text{and } \hat{\mathbf{r}}_{x_1 d_1} = \mathbf{B}_1\hat{\mathbf{R}}_x[i]\mathbf{s}_1 = \frac{1}{L}\mathbf{B}_1\mathbf{X}_0[i]\mathbf{X}_0^t[i]\mathbf{s}_1$$

computing $\mathbf{w}_{GSC}^t[i] = \mathbf{r}_{x_1 d_1}^t[i]\mathbf{R}_{x_1}^{-1}[i]$ (29);

estimating $\hat{b}_1 = \mathrm{sgn}((\mathbf{u}_1^t - \mathbf{w}_{GSC}^t[\hat{i}]\mathbf{B}_1)\mathbf{x}[\hat{i}])$ (35).

wherein $\mathbf{u}_1^t - \mathbf{w}_{GSC}^t[i]\mathbf{B}_1$ (30a) is a weight vector; and

computing $y[i] = (\mathbf{u}_1^t - \mathbf{w}_{GSC}^t[i]\mathbf{B}_1)\mathbf{x}[i]$.   (30b).

6. The method of claim 1, wherein the step of updating weight coefficients further comprises the steps of:

applying $\mathbf{X}_0[i] \triangleq [\mathbf{x}^{(1)}[i], ..., \mathbf{x}^{(L)}[i]]$, wherein L is number of independent samples of an observation vector $\mathbf{x}^{(m)}[i]$ and s_1 is a designated sender's spreading code;

applying $\hat{\mathbf{u}}_1 = \dfrac{\mathbf{s}_1}{\|\mathbf{s}_1\|}$;

applying $\hat{\mathbf{B}}_1 = \mathbf{I} - \hat{\mathbf{u}}_j \hat{\mathbf{u}}_j^t$;

for $j = 1$ to $(M-1)$, computing d_j and $\mathbf{x}_j$

$$\mathbf{d}_j^t[i] \triangleq [\hat{d}_j^{(1)}[i], ..., \hat{d}_j^{(L)}[i]] = \hat{\mathbf{u}}_j^t[i]\,\mathbf{X}_{j-1}[i],$$

$$\mathbf{X}_j[i] \triangleq [\mathbf{x}_j^{(1)}[i], ..., \mathbf{x}_j^{(L)}[i]] = \hat{\mathbf{B}}_j[i]\,\mathbf{X}_{j-1}[i] ;$$

computing $(j+1)$th stage basis vector,

$$\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i] = \frac{1}{L}\sum_{m=1}^{L}\mathbf{x}_j^{(m)}[i]d_j^{(m)}[i]^* = \frac{1}{L}\mathbf{X}_j[i]\,\mathbf{d}_j[i]$$

$$\hat{\delta}_{j+1}[i] = \left\|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]\right\|$$

$$\hat{\mathbf{u}}_{j+1}[i] = \frac{\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]}{\hat{\delta}_{j+1}[i]} ;$$

computing $(j+1)$th blocking matrix $\hat{\mathbf{B}}_{j+1}$

$$\hat{\mathbf{B}}_{j+1}[i] = \mathbf{I} - \hat{\mathbf{u}}_{j+1}[i]\hat{\mathbf{u}}_{j+1}^t[i] ;$$

computing $d_M^{(m)}[i]$ and setting it equal to $\in_M^{(m)}[i]$

$$\mathbf{d}_M^t[i] \triangleq [\hat{d}_M^{(1)}[i], ..., \hat{d}_M^{(L)}[i]] = \mathbf{e}_M^t[i] = \hat{\mathbf{u}}_M^t[i]\,\mathbf{X}_{M-1}[i] ;$$

applying $\hat{\sigma}_{d_M}^2[i] = \dfrac{1}{L}\sum_{m=1}^{L}\left|\hat{d}_M^{(m)}[i]\right|^2 = \hat{\xi}_M[i]$, $\hat{\omega}_M[i] = \hat{\xi}_M^{-1}[i]\hat{\delta}_M[i]$;

for $j = (M-1)$ to 2, estimating variance of $d_j[i]$

$$\hat{\sigma}_{d_j}^2[i] = \frac{1}{L}\sum_{m=1}^{L}\left|\hat{d}_j^{(m)}[i]\right|^2 ;$$

estimating variance of $\in_j$

$$\hat{\xi}_j[i] \triangleq \hat{\sigma}_{\in_j}^2[i] = \hat{\sigma}_{d_j}^2[i] - \hat{\xi}_{j+1}^{-1}[i]\hat{\delta}_{j+1}^2[i] ;\text{ and}$$

computing jth scalar Wiener filter $\hat{\omega}_j[i]$

43

$$\hat{\omega}_j[i] = \frac{\hat{\delta}_j[i]}{\hat{\xi}_j[i]} \ .$$

7.   The method of claim 1, wherein the step of updating weight coefficients further comprises the steps of:

applying $\mathbf{X}_0[i] \triangleq [\mathbf{x}^{(1)}[i], \dots, \mathbf{x}^{(L)}[i]]$,wherein L is number of independent samples of an observation vector $\mathbf{x}^{(m)}[i]$ and s_1 is a designated sender's spreading code;

applying $\hat{\mathbf{u}}_1 = \frac{\mathbf{s}_1}{\|\mathbf{s}_1\|}$ and $\mathbf{x}_0[i] = \mathbf{x}[i]$;

for $j = 1$ to $(M-1)$, computing d_j and $\mathbf{x}_j$

$$d_j[i] = \hat{\mathbf{u}}_j^\dagger[i] \, \mathbf{x}_{j-1}[i]$$

$$\mathbf{x}_j[i] = \mathbf{x}_{j-1}[i] - \hat{\mathbf{u}}_j[i] \, d_j[i]$$

$$\mathbf{d}_j^\dagger[i] \triangleq [\hat{d}_j^{(1)}[i], \dots, \hat{d}_j^{(L)}[i]] = \hat{\mathbf{u}}_j^\dagger[i] \, \mathbf{X}_{j-1}[i] ,$$

$$\mathbf{X}_j[i] \triangleq [\mathbf{x}_j^{(1)}[i], \dots, \mathbf{x}_j^{(L)}[i]] = \mathbf{X}_{j-1}[i] - \hat{\mathbf{u}}_j[i] \, \mathbf{d}_j^\dagger[i] ;$$

computing $(j+1)$th stage basis vector,

$$\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i] = \frac{1}{L}\sum_{m=1}^{L} \mathbf{x}_j^{(m)}[i] d_j^{(m)}[i]^* = \frac{1}{L}\mathbf{X}_j[i] \, \mathbf{d}_j[i]$$

$$\hat{\delta}_{j+1}[i] = \left\| \hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i] \right\|$$

$$\hat{\mathbf{u}}_{j+1}[i] = \frac{\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]}{\hat{\delta}_{j+1}[i]} ;$$

computing $d_M^{(m)}[i]$ and setting it equal to $\in_M^{(m)}[i]$

$$\mathbf{d}_M^\dagger[i] \triangleq [\hat{d}_M^{(1)}[i], , \hat{d}_M^{(L)}[i]] = \mathbf{e}_M^\dagger[i] = \hat{\mathbf{u}}_M^\dagger[i] \, \mathbf{X}_{M-1}[i] ;$$

applying $\hat{\sigma}_{d_M}^2[i] = \frac{1}{L}\sum_{m=1}^{L}\left|\hat{d}_M^{(m)}[i]\right|^2 = \hat{\xi}_M[i], \ \hat{\omega}_M[i] = \hat{\xi}_M^{-1}[i]\hat{\delta}_M[i] ;$

for $j = (M-1)$ to 2, estimating variance of $d_j[i]$, $\hat{\sigma}_{d_j}^2[i] = \frac{1}{L}\sum_{m=1}^{L}\left|\hat{d}_j^{(m)}[i]\right|^2$;

estimating variance of $\in_j$, $\hat{\xi}_j[i] \triangleq \hat{\sigma}_{\in_j}^2[i] = \hat{\sigma}_{d_j}^2[i] - \hat{\xi}_{j+1}^{-1}[i]\hat{\delta}_{j+1}^2[i]$; and

computing jth scalar Wiener filter by $\hat{\omega}_j[i]$, $\hat{\omega}_j[i] = \dfrac{\hat{\delta}_j[i]}{\hat{\xi}_j[i]}$.

8. The method of claim 1, wherein the steps of updating weight coefficients and using the updated weight coefficients further comprises the steps of:

for $k = 1$ to n, applying

$$\hat{\mathbf{r}}_{\mathbf{x}_0 d_0}^{(k)}[i] = \mathbf{s}_1, \quad \hat{\mathbf{u}}_1^{(k)}[i] = \frac{\mathbf{s}_1}{\|\mathbf{s}_1\|}, \text{ and } \hat{\delta}_1^{(k)}[i] = \|\mathbf{s}_1\|, \text{ wherein } \mathbf{x}_0^{(k)}[i] \text{ is the}$$

received data vector, s_1 is a designated sender's spreading code, and k is kth clock time, where $k = 1$ is the first time the data is observed ;

for $j = 1$ to $(M - 1)$, applying

$$d_j^{(k)}[i] = \hat{\mathbf{u}}_j^{(k)}[i]^\dagger \mathbf{x}_{j-1}^{(k)}[i], \text{ and}$$

$$\mathbf{x}_j^{(k)}[i] = \mathbf{x}_{j-1}^{(k)}[i] - \hat{\mathbf{u}}_j^{(k)}[i] d_j^{(k)}[i] ;$$

computing $(j + 1)th$ stage basis vector,

$$\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i] = (1 - \alpha) \hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k-1)}[i] + \mathbf{x}_j^{(k)}[i] d_j^{(k)}[i]^*,$$

$$\hat{\delta}_{j+1}^{(k)}[i] = \left\| \hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i] \right\|,$$

$$\hat{\mathbf{u}}_{j+1}^{(k)}[i] = \frac{\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i]}{\hat{\delta}_{j+1}^{(k)}[i]} \text{ , wherein } \alpha \text{ is a time constant;}$$

applying $\in_M^{(k)}[i] = d_M^{(k)}[i]^\dagger = \hat{\mathbf{u}}_M^{(k)}[i]^\dagger \mathbf{x}_{M-1}^{(k)}[i] ;$

for $j = M$ to 2, estimating variance of $\in_j^{(k)}[i]$

$$\hat{\xi}_j^{(k)}[i] = (\hat{\delta}_{\in_j}^{(k)})^2[i] = (1 - \alpha) \hat{\xi}_j^{(k-1)}[i] + \left| \in_j^{(k)}[i] \right|^2 ;$$

computing jth scalar Wiener filter $\hat{\omega}_j^{(k)}[i]$

$$\hat{\omega}_j^{(k)}[i] = \frac{\hat{\delta}_j^{(k)}[i]}{\hat{\xi}_j^{(k)}[i]} \text{ ; and}$$

computing $(j - 1)$th error signal $\in_{j-1}^{(k)}[i]$

$$\in_{j-1}^{(k)}[i] = d_{j-1}^{(k)}[i] - \hat{\omega}_j^{(k)}[i]^* \in_j^{(k)}[i] \text{ ; wherein output at time } k\text{th}$$

is $y^{(k)}[i] = \in_1^{(k)}[i].$

45

9. An adaptive near-far resistant receiver for an asynchronous wireless system comprising:

means for receiving an asynchronous data vector including a spreading code;

5   using the received asynchronous data vector, means for updating weight coefficients of an adaptive filter without prior knowledge of synchronization of the spreading code of the data vector;

using the updated weight coefficients, means for determining synchronization of the spreading code; and

10   means for demodulating the output of the filter using the determined synchronization of the spreading code for obtaining a filtered data vector.

10. The receiver of claim 9, further comprising means for dividing the data vector represented by $\mathbf{x}[i]$ into two channels $\mathbf{x}_1[i]$ and $d_1[i]$ using a transformation $\mathbf{T}_1$

15   on $\mathbf{x}[i]$, represented by $\mathbf{T}_1\mathbf{x}[i]$, wherein the transformed data vector $\mathbf{x}[i]$ does not contain information about a designated sender's spreading code s_1, and $d_1[i]$ contains primarily only information about the spreading code s_1 and residual data from correlation of s_1 and $\mathbf{x}[i]$.

20   11. The receiver of claim 10, wherein the transformation $\mathbf{T}_1$ is defined by

$$\mathbf{T}_1 = \begin{bmatrix} \mathbf{u}_1^t \\ \mathbf{B}_1 \end{bmatrix}, \qquad\qquad (16)$$

where $\mathbf{B}_1$ is a blocking matrix whose rows are composed of any orthonormal

basis set of the nullspace of the normalized signal vector $\mathbf{u}_1 = \mathbf{s}_1 / \sqrt{\mathbf{s}_1^t \mathbf{s}_1}$,

and where $\mathbf{B}_1\mathbf{u}_1 = \mathbf{B}_1\mathbf{s}_1 = 0.$ (17)

25

12. The receiver of claim 9, wherein the means for determining the synchronization of the spreading code comprises:

means for computing $\hat{i}$, the time occurrence of the information data bit, from the equation;

30

$$\left| \text{Re}\{y[\hat{i}]\} \right| = \max_{k \in \{0, 1, \ldots, NS-1\}} \left| \text{Re}\{y[i-k]\} \right| \qquad (30c),$$

where $y[i] = \mathbf{w}[i]^{t} \mathbf{x}[i]$ is filtered output from a likelihood ratio test at clock time i detecting sequentially maximum of all likelihood ratio tests in the set $Y[i]$ given by $Y[i] = \{ \left| \text{Re}\{y[i]\} \right|, \ldots, \left| \text{Re}\{y[i-NS+1]\} \right| \}$, where N is number of chips in the spreading code and S is number of samples per chip time.

13. The receiver of claim 9, wherein the means for using the received asynchronous data vector, to update weight coefficients further comprises:

means for applying $\mathbf{X}_0[i] \triangleq [\mathbf{x}^{(1)}[i], \ldots, \mathbf{x}^{(L)}[i]]$,wherein L is number of independent samples of an observation vector $\mathbf{x}^{(m)}[i]$ and s_1 is a designated sender's spreading code;

means for applying $\hat{\mathbf{u}}_1 = \dfrac{\mathbf{s}_1}{\|\mathbf{s}_1\|}$;

means for applying $\hat{\mathbf{B}}_1 = \mathbf{I} - \hat{\mathbf{u}}_j \hat{\mathbf{u}}_j^{t}$;

for $j = 1$ to $(M-1)$, means for computing d_j and x_j

$$\mathbf{d}_j^{t}[i] \triangleq [\hat{d}_j^{(1)}[i], \ldots, \hat{d}_j^{(L)}[i]] = \hat{\mathbf{u}}_j^{t}[i] \mathbf{X}_{j-1}[i],$$

$$\mathbf{X}_j[i] \triangleq [\mathbf{x}_j^{(1)}[i], \ldots, \mathbf{x}_j^{(L)}[i]] = \hat{\mathbf{B}}_j[i] \mathbf{X}_{j-1}[i] ;$$

means for computing $(j+1)$th stage basis vector,

$$\hat{\mathbf{r}}_{x_j d_j}[i] = \frac{1}{L} \sum_{m=1}^{L} \mathbf{x}_j^{(m)}[i] d_j^{(m)}[i]^{*} = \frac{1}{L} \mathbf{X}_j[i] \, \mathbf{d}_j[i]$$

$$\hat{\delta}_{j+1}[i] = \left\| \hat{\mathbf{r}}_{x_j d_j}[i] \right\|$$

$$\hat{\mathbf{u}}_{j+1}[i] = \frac{\hat{\mathbf{r}}_{x_j d_j}[i]}{\hat{\delta}_{j+1}[i]} ;$$

means for computing $(j+1)$th blocking matrix $\hat{\mathbf{B}}_{j+1}$

$$\hat{\mathbf{B}}_{j+1}[i] = \mathbf{I} - \hat{\mathbf{u}}_{j+1}[i] \hat{\mathbf{u}}_{j+1}^{t}[i] ;$$

means for computing $d_M^{(m)}[i]$ and set it equal to $\in_M^{(m)}[i]$

$$\mathbf{d}_M^{t}[i] \triangleq [\hat{d}_M^{(1)}[i], \ldots, \hat{d}_M^{(L)}[i]] = \mathbf{e}_M^{t}[i] = \hat{\mathbf{u}}_M^{t}[i] \mathbf{X}_{M-1}[i] ;$$

means for applying $\hat{\sigma}^2_{d_M}[i] = \frac{1}{L}\sum_{m=1}^{L}\left|\hat{d}_M^{(m)}[i]\right|^2 = \hat{\xi}_M[i]$, $\hat{\omega}_M[i] = $

$\hat{\xi}_M^{-1}[i]\hat{\delta}_M[i]$;

for $j = (M-1)$ to 2, means for estimating variance of $d_j[i]$

$$\hat{\sigma}^2_{d_j}[i] = \frac{1}{L}\sum_{m=1}^{L}\left|\hat{d}_j^{(m)}[i]\right|^2 \; ;$$

means for estimate variance of $\in_j$

$$\hat{\xi}_j[i] \triangleq \hat{\sigma}^2_{\in_j}[i] = \hat{\sigma}^2_{d_j}[i] - \hat{\xi}_{j+1}^{-1}[i]\hat{\delta}^2_{j+1}[i] \; ; \text{ and}$$

means for computing jth scalar Wiener filter $\hat{\omega}_j[i]$

$$\hat{\omega}_j[i] = \frac{\hat{\delta}_j[i]}{\hat{\xi}_j[i]} \; .$$

14. The receiver of claim 9, wherein the means for using the received asynchronous data vector, to update weight coefficients further comprises:

means for applying $\mathbf{X}_0[i] \triangleq [\mathbf{x}^{(1)}[i], \, ..., \, \mathbf{x}^{(L)}[i]]$,wherein L is number of independent samples of an observation vector $\mathbf{x}^{(m)}[i]$ and s_1 is a designated sender's spreading code;

means for applying $\hat{\mathbf{u}}_1 = \frac{\mathbf{s}_1}{\|\mathbf{s}_1\|}$ and $\mathbf{x}_0[i] = \mathbf{x}[i]$;

for $j = 1$ to $(M-1)$, means for computing d_j and $\mathbf{x}_j$

$$d_j[i] = \hat{\mathbf{u}}_j^{\dagger}[i]\,\mathbf{x}_{j-1}[i]$$

$$\mathbf{x}_j[i] = \mathbf{x}_{j-1}[i] - \hat{\mathbf{u}}_j[i]\,d_j[i]$$

$$\mathbf{d}_j^{\dagger}[i] \triangleq [\hat{d}_j^{(1)}[i], \, ..., \, \hat{d}_j^{(L)}[i]] = \hat{\mathbf{u}}_j^{\dagger}[i]\,\mathbf{X}_{j-1}[i],$$

$$\mathbf{X}_j[i] \triangleq [\mathbf{x}_j^{(1)}[i], \, ..., \, \mathbf{x}_j^{(L)}[i]] = \mathbf{X}_{j-1}[i] - \hat{\mathbf{u}}_j[i]\,\mathbf{d}_j^{\dagger}[i] \; ;$$

means for computing $(j+1)$th stage basis vector,

$$\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i] = \frac{1}{L}\sum_{m=1}^{L}\mathbf{x}_j^{(m)}[i]d_j^{(m)}[i]^* = \frac{1}{L}\mathbf{X}_j[i]\,\mathbf{d}_j[i]$$

$$\hat{\delta}_{j+1}[i] = \left\|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]\right\|$$

$$\hat{\mathbf{u}}_{j+1}[i] = \frac{\hat{\mathbf{r}}_{x_j d_j}[i]}{\hat{\delta}_{j+1}[i]} \; ;$$

means for computing $d_M^{(m)}[i]$ and set it equal to $\in_M^{(m)}[i]$

$$\mathbf{d}_M^t[i] \triangleq [\hat{d}_M^{(1)}[i], , \hat{d}_M^{(L)}[i]] = \mathbf{e}_M^t[i] = \hat{\mathbf{u}}_M^t[i] \, \mathbf{X}_{M-1}[i] \; ;$$

means for applying $\hat{\sigma}_{d_M}^2[i] = \dfrac{1}{L}\sum_{m=1}^{L} \left|\hat{d}_M^{(m)}[i]\right|^2 = \hat{\xi}_M[i]$, $\hat{\omega}_M[i] =$

5      $\hat{\xi}_M^{-1}[i]\hat{\delta}_M[i]$;

for $j = (M-1)$ to 2, means for estimating variance of $d_j[i]$, $\hat{\sigma}_{d_j}^2[i] =$

$$\frac{1}{L}\sum_{m=1}^{L}\left|\hat{d}_j^{(m)}[i]\right|^2 \; ;$$

means for estimating variance of $\in_j$, $\hat{\xi}_j[i] \triangleq \hat{\sigma}_{\in_j}^2[i] = \hat{\sigma}_{d_j}^2[i] -$

$\hat{\xi}_{j+1}^{-1}[i]\hat{\delta}_{j+1}^2[i]$; and

10   means for computing jth scalar Wiener filter by $\hat{\omega}_j[i]$, $\hat{\omega}_j[i] = \dfrac{\hat{\delta}_j[i]}{\hat{\xi}_j[i]}$.

15.   The receiver of claim 9, wherein the means for using the received asynchronous data and updates weight coefficients further comprises:

for $k = 1$ to n, means for applying

15      $\hat{\mathbf{r}}_{x_0 d_0}^{(k)}[i] = \mathbf{s}_1, \; \hat{\mathbf{u}}_1^{(k)}[i] = \dfrac{\mathbf{s}_1}{\|\mathbf{s}_1\|}$, and $\hat{\delta}_1^{(k)}[i] = \|\mathbf{s}_1\|$, wherein $\mathbf{x}_0^{(k)}[i]$ is the

received data vector, s_1 is a designated sender's spreading code, and k is kth clock time, where $k = 1$ is the first time the data is observed ;

for $j = 1$ to $(M-1)$, means for applying

$$d_j^{(k)}[i] = \hat{\mathbf{u}}_j^{(k)}[i]^t \, \mathbf{x}_{j-1}^{(k)}[i], \text{ and}$$

20      $$\mathbf{x}_j^{(k)}[i] = \mathbf{x}_{j-1}^{(k)}[i] - \hat{\mathbf{u}}_j^{(k)}[i] \, d_j^{(k)}[i] \; ;$$

means for computing $(j+1)$th stage basis vector,

$$\hat{\mathbf{r}}_{x_j d_j}^{(k)}[i] = (1-\alpha)\hat{\mathbf{r}}_{x_j d_j}^{(k-1)}[i] + \mathbf{x}_j^{(k)}[i]d_j^{(k)}[i]^{*},$$

49

$$\hat{\delta}_{j+1}^{(k)}[i] = \left\| \hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i] \right\|,$$

$$\hat{\mathbf{u}}_{j+1}^{(k)}[i] = \frac{\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i]}{\hat{\delta}_{j+1}^{(k)}[i]} \quad , \text{wherein } \alpha \text{ is a time constant;}$$

means for applying $\in_M^{(k)}[i] = d_M^{(k)}[i]^\dagger = \hat{\mathbf{u}}_M^{(k)}[i]^\dagger \mathbf{x}_{M-1}^{(k)}[i]$;

for $j = M$ to 2, means for estimating variance of $\in_j^{(k)}[i]$

$$\hat{\xi}_j^{(k)}[i] = (\hat{\delta}_{\in_j}^{(k)})^2[i] = (1 - \alpha)\hat{\xi}_j^{(k-1)}[i] + \left| \in_j^{(k)}[i] \right|^2 ;$$

means for computing jth scalar Wiener filter $\hat{\omega}_j^{(k)}[i]$

$$\hat{\omega}_j^{(k)}[i] = \frac{\hat{\delta}_j^{(k)}[i]}{\hat{\xi}_j^{(k)}[i]} \quad ; \text{ and}$$

means for computing $(j-1)$th error signal $\in_{j-1}^{(k)}[i]$

$$\in_{j-1}^{(k)}[i] = d_{j-1}^{(k)}[i] - \hat{\omega}_j^{(k)}[i]^* \in_j^{(k)}[i] \; ; \text{wherein output at time } k\text{th is } y^{(k)}[i] =$$

$\in_1^{(k)}[i]$.

16. The receiver of claim 9, wherein the means for using the received asynchronous data vector, to update weight coefficients further comprises:

means for computing maximum likelihood estimator for $\mathbf{R}_x[i]$

$$\hat{\mathbf{R}}_x[i] = \frac{1}{L}\sum_{m=1}^{L} \mathbf{x}^{(m)}[i]\mathbf{x}^{(m)*}[i] = \frac{1}{L}\mathbf{X}_0[i]\mathbf{X}_0^\dagger[i] .$$

wherein, $\mathbf{x}^{(m)}[i]$ is an observation vector at a sampling time iT_s of the mth symbol, L is the number of independent samples of the observation vector $\mathbf{x}^{(m)}[i]$ for the initial acquisition of detector parameters, and the data is given in matrix form by

$$\mathbf{X}_0[i] \triangleq [\mathbf{x}^{(1)}[i], ..., \mathbf{x}^{(L)}[i]] ;$$

means for computing

$$\hat{\mathbf{R}}_{x_1}[i] = \mathbf{B}_1\hat{\mathbf{R}}_{x_1}[i]\mathbf{B}_1^\dagger = \frac{1}{L}\mathbf{B}_1\mathbf{X}_0[i]\mathbf{X}_0^\dagger[i]\mathbf{B}_1^\dagger$$

$$\text{and } \hat{\mathbf{r}}_{\mathbf{x}_1 d_1} = \mathbf{B}_1 \hat{\mathbf{R}}_\mathbf{x}[i]\mathbf{s}_1 = \frac{1}{L}\mathbf{B}_1 \mathbf{X}_0[i]\mathbf{X}_0^t[i]\mathbf{s}_1$$

means for computing $\mathbf{w}_{\text{GSC}}^t[i] = \mathbf{r}_{\mathbf{x}_1 d_1}^t[i]\mathbf{R}_{\mathbf{x}_1}^{-1}[i]$ (29);

means for estimating $\hat{b}_1 = \text{sgn}((\mathbf{u}_1^t - \mathbf{w}_{\text{GSC}}^t[\hat{i}]\mathbf{B}_1)\mathbf{x}[\hat{i}])$ (35) , wherein

$\mathbf{u}_1^t - \mathbf{w}_{\text{GSC}}^t[i]\mathbf{B}_1$ (30a) is a weight vector; and

5   means for computing $y[i] = (\mathbf{u}_1^t - \mathbf{w}_{\text{GSC}}^t[i]\mathbf{B}_1)\mathbf{x}[i]$.   (30b).

17. A digital signal processor having stored thereon a set of instructions including instructions for filtering interference and noise of an asynchronous wireless signal, when executed, the instructions cause the digital signal processor to

10   perform the steps of:

receiving an asynchronous data vector including a spreading code;

using the received asynchronous data vector, updating weight coefficients of an adaptive filter without prior knowledge of synchronization of the spreading code of the data vector;

15   using the updated weight coefficients information data bits to determine the synchronization of the spreading code of the data vector; and

demodulating the output of the filter using the determined synchronization of the spreading code of the data vector for obtaining a filtered data vector.

20   18.   The digital signal processor of claim 17, further comprising instructions for dividing the data vector represented by $\mathbf{x}[i]$ into two channels $\mathbf{x}_1[i]$ and $d_1[i]$ using a transformation $\mathbf{T}_1$ on $\mathbf{x}[i]$, represented by $\mathbf{T}_1\mathbf{x}[i]$, wherein the transformed data vector $\mathbf{x}[i]$ does not contain information about a designated sender's spreading code s_1, and $d_1[i]$ contains primarily only information about the spreading code s_1 and residual data

25   from correlation of s_1 and $\mathbf{x}[i]$.

19.   The digital signal processor of claim 18, wherein the transformation $\mathbf{T}_1$ is defined by

$$\mathbf{T}_1 = \begin{bmatrix} \mathbf{u}_1^t \\ \mathbf{B}_1 \end{bmatrix} , \qquad (16)$$

51

where $\mathbf{B}_1$ is a blocking matrix whose rows are composed of any orthonormal basis set of the nullspace of the normalized signal vector $\mathbf{u}_1 = \mathbf{s}_1 / \sqrt{\mathbf{s}_1^t \mathbf{s}_1}$, and where $\mathbf{B}_1 \mathbf{u}_1 = \mathbf{B}_1 \mathbf{s}_1 = 0$. $\hspace{2cm}$ (17)

20. The digital signal processor of claim 17, wherein the instructions for determining synchronization comprises instructions for:

computing $\hat{i}$, the time occurrence of the information data bit, from the equation;

$$\left| \mathrm{Re}\{y[\hat{i}]\} \right| = \max_{k \in \{0,1,...,NS-1\}} \left| \mathrm{Re}\{y[i-k]\} \right| \hspace{1cm} (30c),$$

where $y[i] = \mathbf{w}[i]^t \mathbf{x}[i]$ is filtered output from a likelihood test at clock time I detecting sequentially maximum of all likelihood tests in the set $Y[i]$ given by

$Y[i] = \{ \left| \mathrm{Re}\{y[i]\} \right|, ..., \left| \mathrm{Re}\{y[i-NS+1]\} \right| \}$, where N is number of chips in the spreading code and S is number of samples per chip time.

21. An adaptive receiver for filtering interference and noise of an asynchronous wireless signal comprising:

means for receiving an asynchronous data vector including information data bits;

means for updating weight coefficients of an adaptive filter without a prior knowledge of synchronization of the information data bits;

using the updated weight coefficient, means for determining the start of the information data bits; and

means for demodulating the output of the adaptive filter.

22. The adaptive receiver of claim 21, further comprising means for dividing the data vector represented by $\mathbf{x}[i]$ into two channels $\mathbf{x}_1[i]$ and $d_1[i]$ using a transformation $\mathbf{T}_1$ on $\mathbf{x}[i]$, represented by $\mathbf{T}_1 \mathbf{x}[i]$, wherein the transformed data vector $\mathbf{x}[i]$ does not contain information about a designated sender's spreading code s_1, and $d_1[i]$ contains primarily only information about the spreading code s_1 and residual data from correlation of s_1 and $\mathbf{x}[i]$.

23. The adaptive receiver of claim 22, wherein the transformation $\mathbf{T}_1$ is defined by

$$\mathbf{T}_1 = \begin{bmatrix} \mathbf{u}_1^t \\ \mathbf{B}_1 \end{bmatrix}, \qquad (16)$$

where $\mathbf{B}_1$ is a blocking matrix whose rows are composed of any orthonormal

5   basis set of the nullspace of the normalized signal vector $\mathbf{u}_1 = \mathbf{s}_1 / \sqrt{\mathbf{s}_1^t \mathbf{s}_1}$,

and where $\mathbf{B}_1 \mathbf{u}_1 = \mathbf{B}_1 \mathbf{s}_1 = 0.$ (17)

24. The adaptive receiver of claim 21, wherein the means for determining the start of the information data bits comprises means for:

10   computing $\hat{i}$, the time occurrence of the information data bit, from the equation;

$$\left| \mathrm{Re}\{y[\hat{i}]\} \right| = \max_{k \in \{0, 1, ..., NS-1\}} \left| \mathrm{Re}\{y[i-k]\} \right| \qquad (30c),$$

where $y[i] = \mathbf{w}[i]^t \mathbf{x}[i]$ is filtered output from a likelihood ratio test at clock time i detecting sequentially maximum of all likelihood ratio tests in

15   the set $Y[i]$ given by

$Y[i] = \{ \left| \mathrm{Re}\{y[i]\} \right|, ..., \left| \mathrm{Re}\{y[i-NS+1]\} \right| \}$, where N is number of chips

in the spreading code and S is number of samples per chip time.

25. The adaptive receiver of claim 21, wherein the means for determining the start of

20   the information data bits comprises:

for $k = 1$ to n, means for applying

$$\hat{\mathbf{r}}_{\mathbf{x}_0 d_0}^{(k)}[i] = \mathbf{s}_1, \quad \hat{\mathbf{u}}_1^{(k)}[i] = \frac{\mathbf{s}_1}{\|\mathbf{s}_1\|}, \text{ and } \quad \hat{\delta}_1^{(k)}[i] = \|\mathbf{s}_1\|, \text{ wherein } \mathbf{x}_0^{(k)}[i] \text{ is the}$$

received data vector, s_1 is a designated sender's spreading code, and k

is kth clock time, where $k = 1$ is the first time the data is observed ;

25   for $j = 1$ to $(M - 1)$, means for applying

$$d_j^{(k)}[i] = \hat{\mathbf{u}}_j^{(k)}[i]^t \mathbf{x}_{j-1}^{(k)}[i], \text{ and}$$

$$\mathbf{x}_j^{(k)}[i] = \mathbf{x}_{j-1}^{(k)}[i] - \hat{\mathbf{u}}_j^{(k)}[i] \, d_j^{(k)}[i] ;$$

means for computing $(j + 1)th$ stage basis vector,

$$\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i] = (1 - \alpha)\,\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k-1)}[i] + \mathbf{x}_j^{(k)}[i]d_j^{(k)}[i]^{*},$$

$$\hat{\delta}_{j+1}^{(k)}[i] = \left\| \hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i] \right\|,$$

$$\hat{\mathbf{u}}_{j+1}^{(k)}[i] = \frac{\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i]}{\hat{\delta}_{j+1}^{(k)}[i]} \quad \text{, wherein } \alpha \text{ is a time constant;}$$

means for applying $\in_M^{(k)}[i] = d_M^{(k)}[i]^{\dagger} = \hat{\mathbf{u}}_M^{(k)}[i]^{\dagger}\,\mathbf{x}_{M-1}^{(k)}[i]$;

for $j = M$ to 2, means for estimating variance of $\in_j^{(k)}[i]$

$$\hat{\xi}_j^{(k)}[i] = (\hat{\delta}_{\in_j}^{(k)})^2[i] = (1 - \alpha)\,\hat{\xi}_j^{(k-1)}[i] + \left| \in_j^{(k)}[i] \right|^2 \; ;$$

means for computing jth scalar Wiener filter $\hat{\omega}_j^{(k)}[i]$

$$\hat{\omega}_j^{(k)}[i] = \frac{\hat{\delta}_j^{(k)}[i]}{\hat{\xi}_j^{(k)}[i]} \; ; \text{ and}$$

means for computing $(j-1)$th error signal $\in_{j-1}^{(k)}[i]$

$$\in_{j-1}^{(k)}[i] = d_{j-1}^{(k)}[i] - \hat{\omega}_j^{(k)}[i]^{*} \in_j^{(k)}[i] \; ; \text{ wherein output at time } k\text{th is } y^{(k)}[i]$$

$$= \in_1^{(k)}[i].$$